~~electronics~~electronic devices.

2. Description of the ~~Related Art~~related art

Electronic switching devices are well known in the art~~—several alternate~~. Several alternative principles are usually ~~utilizes~~utilized for the purpose of producing electronic switching. One method is MOSFET. It ~~consist~~consists of a ~~P~~-p-type semiconductor with two n-type regions, one ~~of~~ on either end~~, on~~. On the top surface above the ~~P~~-p-type region~~,~~ is a thin layer of oxide insulator~~,~~; on the surface of this insulator ~~there~~ is a polysilicon gate.
~~By applying~~
When a positive voltage is applied to the central electrode, the positive charge on the gate electrode (p/ region) repels the holes ~~at~~on the top surface of the p-type layer. Thermally created conducting electrons in the p-type layer will be attracted by the positive charge. This means~~,~~ that electrons can flow freely from one side to the other and the device is on. If the voltage is removed, there is no current and the device is off.

Another method is that of the bipolar transistor~~, a~~. A bipolar can ~~be~~ have an n-p-n or a p-n-p structure. It is critical that the middle layer (base) be thin for high current gain. Bipolar transistors have restricted current flow. A bipolar transistor can be operated in ~~different~~various regimes that are ~~determent~~determined by the biases of the two junctions~~,~~; the most important of these regimes is the active (normal) mode~~ where~~, in which the emitter-base junction is forward and the collector-base junction is reversed. In the saturation mode, the collector current Ic is a weak function of Ib or Ie. If the cut-off mode set by Ib or Ie ~~equals~~ is equal to zero, the transistor is off and Ie is close to zero. Bipolar transistors are more suitable for high-speed circuits because of their high transconductance. Another advantage of the bipolar transistor is that the threshold for turn-off is less sensitive to process variation. ~~Mosfet~~ The advantage involved in MOSFET transistors, on the other hand, is their less difficult fabrication process.

The present invention ~~is~~ concerns a switching devices based on a change in ~~electric~~electrical charge distribution~~ denoted~~, which is referred to as wave function size change. The ~~notation of~~ term "wave function" is ~~referred to wave function~~defined

energy consumption~~,~~. Another problem is that electron ~~current~~currents have speed limits that set limits to switching time.

SUMMARY OF THE INVENTION

~~It is an~~ An object of the present invention is to provide a switching method ~~of~~ with low energy consumption, fast switching time and reduced heat emission for switching in computing, electronics, optoelectronics or any kind of circuit.

~~For~~In one embodiment of the invention, the switching state is dependent on the particle wave function size in space.

~~For one~~In another embodiment of the invention, the method of changing the particle ~~wave~~wave function size is by means of energy received or transmitted by the particle.

~~For~~In other embodiments of the invention, the switching method ~~is by~~ of changing the particle wave function size is by means of a change in kinetic energy, photonic energy, and potential energy – for example, coulomb potential energy, or phonon energy.

~~For one~~One embodiment of the invention includes a method for detection of the ~~switched~~ switching state, comprising~~:~~ two boundaries ~~in~~on two sides of the switching particle. ~~Wherein~~In that embodiment, the ~~two~~respective switching ~~states~~ state is detected by the corresponding values of the potential between the two boundaries.

~~For one~~One embodiment of the invention ~~include~~includes a silicon layer with phosphorus dopants~~. An~~, an undoped silicon layer, a silicon oxide insulator layer on two sides of the doped silicon layer, an ~~Aluminum~~ aluminum-based metallic contact on the insulator layer, an additional silicon oxide insulator layer and ~~Aluminum~~an aluminum current conductor on said additional silicon oxide insulator layer.

~~For one~~One embodiment of the invention ~~include~~includes a method for detection of the ~~switched~~ switching state wherein the ~~two~~respective switching state~~s~~ is detected by photon detection.

~~For one~~One embodiment of the invention ~~include~~includes a switching device wherein the ~~switched~~switching state depends on the dynamic change of the particle wave function ~~dynamic~~ size ~~change~~ in space.
~~For one~~
One embodiment of the invention ~~include~~includes a switching device comprising: (a) two conductive planes; (b) an electron which can be switched between two ~~state where~~states whereby, in one state, the particle ~~move~~moves to a region between the two ~~plane~~ planes and ~~the~~, in the second state, the particle ~~is moving~~moves outside the region between the two planes, wherein the movement is a translation movement of the ~~all the~~entire particle~~.~~; (c) the ~~two~~respective state ~~are~~is detected by the difference in the charge potential between the two planes.

Further embodiments of the invention include ~~semiconductor or other materials~~ structures and methods of varying scope involving semiconductors or other materials, as well as apparatus, devices, modules and systems making use of such ~~semiconductor or other materials~~ structures and methods. The term "particle" can refer to a group of

more than one particle, for example, an atom or a molecule.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is herein described, by way of example only, with reference to the accompanying drawings, wherein:

~~FIG.~~Fig. 1a is a schematic representation of a switching device based on particle wave function size change~~. Wherein~~, wherein the particle wave function is in its initial size.

~~FIG.~~Fig. 1b is a schematic representation of a switching device based on particle wave function size change, in which the particle ~~increase~~has increased its energy and its wave function size.

~~FIG.~~Fig. 2a is a schematic representation of a switching device; the device is switched to the second state by means of a gain in kinetic energy ~~gain~~ from other particles.

~~FIG.~~Fig. 2b is a schematic representation of a switching device; the device is switched back to the first state by transferring kinetic energy to other particles.

~~FIG.~~Fig. 3a is a schematic representation of a switching device, wherein the switching is based on photon absorption.

~~FIG.~~Fig. 3b is a schematic representation of the device and particle state after ~~it absorbed~~absorbing the photons.

~~FIG.~~Fig. 4a is a schematic representation of a switching device~~.~~, wherein the switching to a larger particle wave function state is based on energy gain from phonons.

~~FIG.~~
Fig. 4b is a schematic representation of a switching device. wherein the switching to a smaller particle wave function state is based on particle energy transferred to phonons.

~~FIG.~~Fig. 5 is a schematic representation of a switching device based on particle wave function size change, wherein the switching is based on potential energy interaction.

~~FIG.~~Fig. 6a is a schematic representation of a switching device~~.~~, wherein the particle wave function is not large enough to fill the detection zone.

~~FIG.~~Fig. 6b is a schematic representation of a switching device~~.~~, wherein the particle wave function ~~fill~~fills the detection zone.

~~FIG.~~Fig. 7 is a schematic representation of a switching device~~.~~, wherein the detection of the switching state is based on photon~~s~~ detection.

~~FIG.~~Fig. 8a is a schematic representation of a switching device~~. Wherein~~, wherein the particle wave function size is static and the current is zero.

~~FIG.~~Fig. 8b is a schematic representation of a switching device, wherein the continuous dynamic change in the particle wave function size ~~change wherein the continues dynamic change producing~~produces a charge current.

~~FIG.~~Fig. 9a is a schematic representation of a switching device in accordance with another embodiment of the invention~~. Wherein~~, wherein the particle is outside the detection zone.

~~FIG.~~Fig. 9b is a schematic representation of the switching device, wherein the particle is inside the detection zone.

~~FIG.~~Fig. 10 is a schematic representation of a switching device in accordance with another embodiment, wherein the particle wave function influences the current.

~~FIG.~~Fig. 11a is a schematic representation of a switching device, wherein the particle is in a smaller range in the cavity due to repulsive potential.

~~FIG.~~Fig. 11b is a schematic representation of a switching device, wherein the particle is in a larger range in the cavity.

~~FIG.~~Fig. 12a is a schematic representation of a switching device in accordance with another embodiment, wherein the particle wave function is in a smaller range.

~~FIG.~~Fig. 12b is a schematic representation of the switching device, wherein the particle wave function is in a larger range.

~~FIG.~~Fig. 13 is a schematic representation of a switching device ~~Wherein particles~~, wherein the particle wave function inside a region of a layer ~~influenced~~ influences the current inside a wire connected parallel to said region.

~~FIG.~~Fig. 14 is a schematic representation of a switching device, wherein the particle wave function expansion inside a first layer ~~influence~~influences, by means of an ~~electric~~electrical potential, the current ~~inside~~ a second layer.

~~FIG.~~Fig. 15 is a schematic representation of a switching device, wherein -the particle wave function expansion inside a first layer ~~influenced~~influences, by ~~electric~~means of an electrical potential, the current inside a second layer, and the expansion or contraction of said wave function, determined by an electrical potential field ~~influenced~~, influences the wave function from external charged areas.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A first preferred embodiment is a switching device based on changes of the ~~particles wave functions~~ particle wave function size inside a container, as illustrated in ~~fig.~~Fig. 1.

The device includes a container **1** (for example, a quantum well~~,~~) and a particle wave function **2** or an expanded wave function **3**.

The ~~notation~~ term "container ~~is referred in~~" constitutes a general reference to any kind of zone~~,~~ which ~~contained~~contains most of the particle wave function. The ~~notation~~ term "particle" can refer to several kind of ~~particle~~particles, for example~~,~~: electron, proton, neutron, atom, molecule or photon~~,~~; the ~~notation~~ term "particle" may refer to one or more than one particle. Fig~~ure~~. 1 ~~present~~presents a two--dimensional wave function, the ~~absolute~~ square of the absolute value of the wave function is the probability distribution of finding the particle~~,~~; the filled area ~~illustrated~~ illustrates an area where ~~it is~~ the particles are most likely to ~~find the particles~~ be found; outside the filled area, there is a low probability ~~to found~~ of finding the particles. The upper curve of the wave function ~~is~~represents the ~~border~~boundary of the area of high probability of finding a particle; it is determined by internal characteristics of the particle wave function mathematically described by a wave packet ~~and it determined~~ , as well as by the wave function interaction with other ~~particle~~ particles in the container. Changes in the particle wave function size derived from changes in the particle energy in one case increasing the particle energy increases- the particle wave function size in the container. ~~Particle~~ The energy gained energy by the particle could be kinetic energy, potential energy or both. Decreasing the particle energy to its initial value ~~results in reverting~~restores the particle wave function size to its initial size. The term "wave function size ~~referred~~" refers to volume

~~distribution on~~
distribution; on devices that are degenerated to two or one ~~or two~~ dimensions ~~are degenerated~~, the size can be denoted as ~~plane~~ planar surface area or length. ~~Particle in fig.~~The particle in Fig. 1 ~~have~~ has an energy denoted by E1; this particle wave function ~~occupied~~ occupies a certain space in the container, which is indicated~~,~~ as the first ~~switched~~ switching state. If the particle has energy E2, where E2 >E1, this ~~caused~~causes the particle wave function inside the container 1 to expand, indicating the second ~~switched~~ switching state.

The operation of the device is heuristically suggested by ~~fig~~Figs. 1, 2. In ~~fig~~Fig. 2, the device is switched from its initial state, characterized by wave function size **5**, to a second state, characterized by a larger wave function size **6** inside the container. ~~The operation of device is heuristically suggested by~~ Fig~~.2. fig.~~ 2a ~~consisted of~~shows a container **4**, ~~of~~ where the initial wave function size ~~wave function~~ **5**~~,~~ has changed to an expanded particle wave function size **6** due to a gain in kinetic energy ~~receipt from~~ ~~external~~ interaction ~~as~~ with external particles **7**. Fig. 2b ~~show~~shows kinetic energy transfer from the particle in container **4** to an external particle **8**, which interacted with the particle in the container ~~that caused~~, causing the reduction of the particle wave function to its initial size **5** and switching the device state ~~is switched~~ back to the first state~~ 1~~. The ~~referred~~referenced change in the particle distribution ~~is~~ does not ~~by~~involve classical ~~transnational~~translational movement; it is a quantum mechanics phenomenon that ~~allow~~ allows the particle to have the probability of occupying areas ~~where~~ which it could not ~~occupied~~occupy by classical ~~transnational~~translational movement ~~on~~ in a given time and with a given particle energy. The switching time between two states can ~~varied~~vary between ~~nano to femto second~~nanoseconds and femtoseconds, the energy required to ~~switched~~ switch the wave function of a single electron could be ~~small~~as low as ten ~~millielectronvolt~~millielectronvolts at room temperature. A similar device structure ~~described in fig.3. Wherein~~, wherein the switching between the two states is achieved by photon absorption or transmission by the switched particle, is illustrated in Fig. 3. The operation of the device is heuristically suggested as particle **9**, with an initial energy E ~~absorbed~~, which absorbs a photon **10** transmitted to the particle **9** by an external source. In ~~fig~~Fig. 3b, the energy of particle **9** ~~energy is increase~~ is increased to ~~energy~~a level of E+p, where p ~~denoted~~denotes the energy due to the photon absorption~~, which caused~~; this increase in turn causes an increase in the particle wave function size **11**. ~~Change~~The change in the particle wave function size ~~represent~~ represents a change in the device ~~switched~~ switching state. ~~A reverse switching between the two states~~ Switching back to the original state can be achieved by photon emission by the particle wave function **11** or by an interaction with an additional

particle or phonon which reduced the switched particle to its initial energy, size and state **9**.

In Fig. 4, the switching between the two states is achieved by phonon or ~~phonons~~ phonon energy exchange with the switched particle. Fig. 4a ~~show~~shows an increase in the switching particle wave function size **12** due to energy gain from an interaction with a phonon **13** that transferred energy to the switched particle. The ~~particle~~ expanded particle wave function is regarded as the second ~~switched~~ switching state of the device. Fig. 4b ~~show~~shows the device reverted to its initial state ~~by an energy transmitted~~ as the result of energy transmission from the particle wave function **12** to an interacting phonon or phonons **14** ~~that caused~~, causing the particle wave function to ~~decrease~~revert to its initial size and the device to switch back to the initial state.

A similar device structure is illustrated in ~~FIG~~ Fig. 5 ~~the~~. The switching device includes two charged areas **15**, **15a** ~~in~~ on two sides of the switching particle **16**.

The operation of the device is heuristically suggested by a particle wave function **16** ~~indicated~~indicating a device ~~switched~~switching state~~,~~; the charged areas **15**, **15a** are used for detection of the device states~~, for~~. For a charged particle ~~like~~ such as an electron, the particle probability distribution is also the charge probability distribution. A change in the charge probability distribution ~~change~~ changes the electric field and ~~electric~~electrical potential on the detection element ~~which,~~; this is detected as a change in the ~~switched~~switching state. In this embodiment, the potential value between the two charged areas **15**, **15a** is different when the particle wave function **16** in the container ~~has~~ is smaller or ~~bigger~~ larger in size, which ~~indicated the two switched states of device~~ respectively indicates the two switching states of the device.

In ~~figure~~Fig. 6, the device has two regions determined by their material composition ~~in~~. In region **17**, the device is made of silicon with dopants ~~like phosphors~~such as phosphorus, or ~~made~~ of an insulator ~~like Al.sub.2 O.sub.3.~~ such as Al_2O_3. Region **18** is made of silicon. The potential detector is made of two charged areas **19**, **20** on two sides of region **18**.

The operation of the device is heuristically suggested by Fig. 6: -The device can be switched between two states. The first state is when the particle wave function is only in region **17**~~,~~; the second state is when the particle wave function has expanded to region **18** as well~~, the~~. The particle wave function is expanded by a kinetic energy ~~gained to~~ gain in the particle ~~and~~; it is returned to ~~it's initial value when the particle kinetic energy returned to~~ its initial value when the particle kinetic energy returns to

its initial value.

The two ~~switched~~ switching states are detected by the potential difference between the two zones **19, 20**, located on ~~opposites~~ opposite sides of region **18**, as the ~~electric~~expansion of the electrical charge ~~expanded~~ to region **18** ~~would change the electric~~changes the electrical potential between ~~element~~elements **19, 20**.

~~Device in fig.~~The device in Fig. 7 is similar to the device in ~~figure~~Fig. 6, but with ~~optic~~ optical detection based on photon scattering **21** or photon absorption **22** or photon transmission **23** of the particle wave function **24**. The detector **25** can be in different places near the container, depending ~~if~~on whether the detection is derived from scattering, absorption or transmission.

The operation of the device is heuristically suggested by Fig. 7~~,~~. The device can be switched between two states. The first state is when the particle wave function is only in the lower region ~~border by lined~~bounded by the dashed line~~,~~; the second state is when the particle wave function is expanded by kinetic energy gained in the particle~~,~~; it is returned to ~~it's~~its initial value when the particle kinetic energy ~~returned~~returns to its initial value. The two ~~switched~~ switching states are detected by optical means ~~that corresponds to particle~~ in accordance with the particle occupancy distribution ~~when~~. When the wave function is in the expanded state, there is a higher probability ~~for~~ of particle occupancy in the optical detection region **21** or **23** ~~the~~; this could be indicated ~~in grater~~as greater absorption or scattering of ~~photon~~photons, thereby ~~indicated a referred switched state~~indicating one referenced switching state, while the second ~~switched~~ switching state could be indicated by lower absorption, less scattering or higher transmission derived from a contracted particle wave function.

~~Second~~An additional preferred embodiment ~~is a~~ consists of the switching device illustrated in?
Fig. 8 ~~the~~. The device ~~include~~ includes a particle wave function **26**~~,~~ inside a container **27**, and a detection element **28**.

The operation of the device is heuristically suggested by a kinetic energy gain ~~by~~ in the electron wave function **26** -in container **27** ~~that caused~~, causing expansion of the quantum mechanics wave function and ~~electric~~the electrical charge distribution ~~expansion, the~~. The expansion is ~~a~~a continuous dynamic ~~continues~~ process ~~that influenced~~which affects the electrons on conductor **28** and ~~caused~~causes conventional electron conduction in **28**. The ~~switch~~switching state is determined by the current value in **28**. The ~~continues~~continuous expansion is

~~Differ~~different from ~~transnational~~translational movement ~~for~~. For example, the center of mass
~~Of~~ of the particle can move ~~less~~ over a smaller distance in expansion mode, compared to ~~transnational~~the translational movement obtained by averaging the probability distribution of the particle mass.

~~Third~~
A third preferred embodiment ~~is a~~ consists of the switching device illustrated ~~fig.~~in Fig. 9
. The device ~~contain~~includes a particle **32**, two electrically influenced planes **29**, **30** ~~And~~ and a container **31**.

~~Two~~ Fig. 9 heuristically suggests the operation of the device, which includes two conductive planes **29**, **30** and a container **31** between them ~~31~~. The conductive planes serve~~d~~ as a potential detector, with minimum deflection of the particle, by detecting change in the ~~electric~~electrical potential between the planes due to the presence of the charged particle. A particle **32** can be switched between two states~~. in~~: In one states, the particle **32** ~~move~~ moves to a region between the two planes **29**, **30**~~,~~; in the second state, the particle ~~is moving~~moves outside the region between the two planes **29**, **30**. In this embodiment, the movement is ~~translatkl n~~ translated into movement of the particle and not into wave function expansion as in the previous embodiments. The two states are detected by the difference in the charge ~~potentials~~ potential values between the two planes **29**;**30**.

~~Fourth~~ A fourth preferred embodiment ~~is a~~ consists of the switching device illustrated in ~~fig.~~Fig. 10?
. The device ~~include~~ includes a conductive element **33**~~,~~ and an electric field screening element **34** with an unscreened region **34a**, wherein the particle wave function can influence~~d~~ the charge current of element **33** near element **34a**.

The operation of the device is heuristically suggested by a first state **35** ~~when~~, in which the particle wave function size is not large enough to be in the unscreened region ~~of~~ **34a**, and a second state **36** ~~when~~, in which the particle wave function is large enough to be ~~at~~in the unscreened region **34a** as well, thereby influencing the electric current in element **33**. The two switching states are determined by the electric current value in element **33**. Each of the two current values indicates a different device state.

An experimental configuration in the super-conducting temperature region related to

~~embodiment 2 and 4 was~~the second and fourth embodiments described above has been fabricated~~,~~ by M.Avinun-Kalish et al. and reviewed by professional referees-Phys Rev let 92 (2004). The operation of the experimental configuration is suggested by a quantum dot containing electrons as in the first region in the fourth embodiment ~~4,~~ ~~next~~described above. Next to the quantum dot is a region ~~area~~ confined by two leads, which serves as the second region in the fourth embodiment ~~4 a~~ described above. A quantum point contact serves as a detector, since ~~it's~~its conductance is changed by the electronic potential in the quantum dot system as the conducting element in the fourth embodiment ~~4.~~described above. The system structure ~~include~~includes confinement in the two dimensional electron gas 53 nm below the surface, area~~l~~ electron density 3.3 *~~10 sup 11cm sub~~ 10^{11} cm^{-2}, mobility ~~of~~ 1.6 *~~10 sup 6 centimeter sup2~~ 10^{6} cm^{2} /Vs at 4.2 ~~Kelvin.~~°K. The confinement is provided by negatively biased metallic gates deposited on the surface of GaAs-AlGaAs heterojunction embedding the 2DEG. By measuring the detector conductance at different values of drain voltages on the detector~~: V sub d = 1.5mv, Vsub d~~: V_d = 1.5 mv, V_d = 1.25mv, ~~Vsub d~~ V_d = 0.9 mv, for two ~~temperature T sub k1 equals~~temperatures: T_{k1} = 41 ~~micro~~ µev and ~~T sub k2 equals~~T_{k2} = 12 ~~micro~~ µev, a correlation between the quantum dot temperature and the detector conduction was experimentally verified ~~that~~. That correlation ~~result~~ results from kinetic energy gained by the increase in temperature ~~raise that~~, which expanded the electron wave function from ~~a~~ the first region of the quantum dot to the second region in the device as well, thereby ~~influenced~~influencing the current in the wire detector. The size of the electronic wave function is described in the paper as linearly proportional to ~~fermi~~Fermi velocity, which~~,~~ is proportional to ~~the~~ temperature and related to electron kinetic energy.

~~Fifth~~A fifth preferred embodiment ~~is a~~ consists of the switching device ~~described in fig.~~ illustrated in Fig. 11
~~consist of~~. The device consists of repulsive ~~electric~~electrical potential contacts **37, 38** and a particle wave function **39.**

The operation of the device is heuristically suggested in ~~fig.11~~Fig. 11 by repulsive ~~electric~~electrical potential contacts **37, 38** which create ~~an electric~~ a repulsive electrical potential on a particle wave function **39** between them. The particle size ~~is~~ depends on the repulsive potential value; the larger ~~is~~ the repulsive potential value, the smaller ~~become~~ the particle wave function size~~, this~~ becomes. This method of changing the wave function size is different from the method described in the previous embodiments ~~and~~; it is based on repulsive forces from the two charge planes towards the particle container. By reducing the repulsive potential value, the particle

wave function size expands, thus achieving two states denoted by two particle wave function sizes. To revert to the initial state, the repulsive potentials are ~~reverted to there~~restored to their initial value and the particle wave function ~~returned~~returns to its initial size. ~~Referring to fig.~~With reference to Fig. 11a, the repulsive potentials of ~~element~~elements 37,_38 are directed toward the particle wave function 39 in the container, which reduces the wave function size. ~~Referring to fig.~~With reference to Fig. 11b, the repulsive potential is reduced due to the repulsive potentials of ~~element~~elements 37,_38 and the particle wave function 39 is expanded, corresponding to the second state of the device. The detector ~~determined~~determining the state ~~could~~may be, for example, any of the detectors described in the previous embodiments.

~~Device~~ The device in Figure 12 ~~contained~~includes two adjacent regions 40,_41, a particle wave function ~~is~~ denoted by diagonal stripes and a detector 43.

The operation of the device is heuristically suggested in ~~fig~~Fig. 12: the first ~~switched~~switching state in Fig. 12a is denoted by a particle wave function in a single region 41 in the container~~-41,~~; the second ~~switched~~switching state in ~~figure~~Fig. 12b is denoted by an expanded particle wave function located in ~~region~~regions 40 and 41. The detection method 43 ~~is~~ may be, for example, any of the ~~method~~detectors described in the previous embodiments. The methods for ~~change~~changing the particle energy ~~can~~may be any of the ~~method~~ methods described in the present patent.

~~Following embodiment describe in more details the devices~~ The following embodiment describes, in greater detail, the construction of the device in the present invention.

Fig~~ure~~. 13 ~~Related~~refers to the first and fourth embodiments~~. Particle~~ described above. The particle wave function can be in one region, or ~~expended~~ can be expanded to a second region ~~too~~as well, as suggested in the first embodiment; the switching states are detected by an electrical conductor, as suggested in ~~first~~ the fourth embodiment~~, the switched state are detected by an electric conductor as suggested in the fourth embodiment. Switching~~. A switching device, generally denoted 50, is schematically ~~described in fig~~illustrated in Fig. 13. Device 50 ~~include~~includes a layer 52 of silicon with ~~phosphorous dopants~~phosphorus dopant concentration of ~~10 sup 17 centimeters sup -3,~~ 10^{17} cm^{-3}, an undoped ~~Si~~ silicon layer 54, silicon oxide ~~insulators~~ insulator layers 56,_58, an undoped ~~Si~~silicon layer 58, ~~Aluminum~~ aluminum-based metallic contacts 60,_62,_68,_70, a silicon oxide ~~insulators~~ insulator layer 64, ~~Aluminum~~and an aluminum conductor 66. Layers 52 have a cross-section of 4 microns ~~by~~x 2 microns and a thickness of 200- angstrom ~~thickness~~units.

The operation of the device is heuristically suggested in Fig. 13. A voltage bias is applied to contact **60**~~of~~, which has a negative charge (relative to contact **62**~~of~~, which has a positive charge), without inserting electrons into layer **52**. The potential difference ~~increase~~increases the kinetic energy in the n--type ~~electron~~ electrons inside layer **52**~~, then electrons~~; the electron wave function ~~expand~~ expands into silicon layer **54**~~,~~; the expanded ~~electric~~electrical charge distribution in layer **54** ~~is changed~~ changes the potential difference between metallic contacts **68**, **70**; said ~~contact~~contacts are connected in parallel to ~~Aluminum~~aluminum conductor **66**, thereby changing the conduction current in ~~Aluminum~~aluminum conductor **66**~~is changed~~.

~~Sixth~~A sixth preferred embodiment is a switching device, generally denoted **80**, which is ~~described~~illustrated in ~~fig.~~Fig. 14 and is related to the fourth embodiment. ~~Expended~~Expanded wave function ~~influence~~influences the conduction on a near-by conducting channel. Device **80** ~~is consist~~consists of ~~82~~ a back source layer ~~,~~ **82**, a layer **84** ~~is~~ of doped silicon ~~layer~~ with boron atoms, ~~86 is~~an inversion layer~~, 88 is~~ **86**, a p--type source region~~, 90 is~~ **88** made of silicon with boron dopants, a p-type drain region~~, layers 88,~~ **90** ~~are~~ made of silicon with boron dopants~~, 92 is~~, a silicon oxide insulator ~~, 94 is~~**92**, a polysilicon gate~~,~~ **94**, silicon oxide insulator layers **96**, **98** ~~are silicon oxide insulator layers,~~, and aluminum metallic contacts **100**, **102** ~~are Aluminum metal contacts~~.

The operation of the device is heuristically suggested in ~~by~~ Fig~~.~~. 14~~:~~. A voltage of 3 ~~volt~~volts is biased through ~~100~~ source ~~positive potential~~**100** to ~~102~~ drain ~~negative potential,~~**102**; electrons do not enter or exit the gate at any time due to the insulating layers **96**, **98**.- A voltage of 0.7 ~~volt initiated~~ volts initiates the polarization process in gate **94**. The gate electrons ~~are moving~~ move in the voltage direction~~coursing~~, causing expansion of the electron wave function due to the gain of kinetic energy, which ~~increase~~ increases the charge distribution and ~~increase~~increases the effective ~~electric~~electrical potential in **94**~~that attracted~~, thus attracting hole conduction from ~~the~~ source **88** towards gate **94** ~~through~~via inversion layer **86**.

Device **80** could be fabricated by means of the following steps of the method set forth in the second preferred embodiment~~method~~:

(a) An ~~N~~ n-type silicon wafer 82 is doped with phosphorus atoms~~, 82~~, concentration of ~~10 sup 1 5 centimeters sup~~ 10^{15} cm^{-3}, thickness 0.5 ~~micron~~ microns.

(b) A layer of silicon dioxide (SiO_2) **92**-, typically 1 micron thick, is grown over the

wafer surface at temperature of 1100~~oC~~°C, to ~~p~~protect the surface ~~served~~which serves as~~as~~ a barrier to dopants during the remainder of processing. Photoresist is deposited onto the surface of the wafer and spun to achieve an
_even distribution of the required thickness.

(c) ~~Photoresist~~ The photoresist layer is exposed to ultraviolet light through a mask, which defines ~~Regions~~the regions into which diffusion is to take place. Areas exposed to UV radiation are ~~polymerised~~ .polymerized. The areas required for diffusion are shielded by the mask and ~~remained~~ remain unaffected.

~~(b)~~
--(d) The exposed areas are etched away together with the underlying silicon dioxide to expose the wafer surface in the window defined by the mask.
~~(f) Thin~~
--(e) A thin layer of SiO_2 92, 0.~~1micron thickness 92~~1 micron thick. is grown over the entire chip surface. Polysilicon is deposited on top of the gate oxide to form the gate structure~~-Polysilicon~~. A polysilicon layer **94**~~-of~~, 0.4 micron thick~~ness~~, doping polysilicon with a phosphorus atom ~~dopnat~~dopant concentration of ~~10 sup 16 centimetre sup~~ 10^{16} cm^{-3} ~~are~~, is deposited by Chemical Vapor Deposition (CVD) at a temperature
of 1230~~o~~°C.
~~(g) Thin~~
--(f) The thin oxide layer is removed to expose areas into which ~~P~~p-type impurities are to be diffused to form the source 88 and drain 90 regions. The diffusion is processed by gas flow ~~contained P~~containing p-type impurity ~~Boron~~boron dopants to regions 88 and 90~~-regions~~, concentration of ~~10 sup 17 centimetre sup~~ 10^{17} cm^{-3} over the ~~surface at high temperature.~~
~~--surface at high temperature.~~
~~(h) Thick~~
--(g) A thick oxide (SiO_2) layer is grown over the entire wafer again,
--masked with photoresist and etched to expose selected areas over the polysilicon gate and the source/drain regions **88**, **90**, where the contact connections are made.
~~(i) Thin layer~~
--(h) A thin later of SiO_2~~-of~~, 0.1 micron thick, is grown over the entire chip surface. ~~Aluminium~~Aluminum, typically 1 micron thick, is deposited over the entire wafer surface~~, thickness typically 1 micron. Metal~~. The metal layer is masked and etched to form the required interconnection pattern.-_A passivating oxide (over-glass oxide) is deposited to protect the wafer pattern~~,~~; the contact holes are patterned for device pad points. ~~-Wafer back is metallised~~The back of the wafer is metallized for substrate connection.

~~Seventh~~A seventh preferred embodiment is a switching device, generally denoted ~~80~~110, which is illustrated in ~~fig.15the~~Fig. 15. The device has a structure similar ~~stricture~~ to the second embodiment, except that the gate ~~have~~ has two charged ~~contact~~ contacts on either side with the same charge sign. In ~~a~~ the case where both ~~contact~~ contacts have negative potential ~~the contact contracted~~, the contacts contract the electron wave function inside the gate. In ~~a~~the case where both ~~contact~~contacts have positive potential, the contacts expanded the electron wave function inside the gate.

Device 110 ~~consist~~consists of a back source layer 112, a layer 114 of doped silicon layer with phosphorus atoms, a silicon oxide insulator 116 ~~is silicon oxide insulator,~~, a p-type source region 118 ~~region~~made of ~~p-type source~~silicon with ~~Boron~~boron dopants, ~~region 120~~ a p-type drain ~~doped~~region 120 made of silicon with boron ~~atoms,~~ ~~122 is~~dopants, a polysilicon gate 122 with phosphorus dopants, silicon oxide insulator layers 124, 126 ~~are silicon oxide insulator layers,~~, and aluminum metallic gate contacts 128, 130 ~~are Aluminum metal gate contact with~~having the same charge sign.

—

—

The operation of the device is heuristically suggested in ~~by~~ Fig. 15~~:~~. A voltage of 3 ~~volt~~volts is biased through ~~118~~ source ~~to~~118 to drain 120 ~~drain,~~; electrons do not enter or exit the gate at any time due to the insulating layers 124, 126. A positive voltage of 0.6 ~~volt~~volts on both ~~contacts~~ 128, 130 ~~contacts expanded~~expands the electrons wave function inside gate 122, which ~~increased~~ increases the charge distribution and ~~increased~~increases the effective ~~electric~~electrical potential in gate 122 ~~and attracted~~, thus attracting hole conduction from ~~the~~ source 118 towards the gate.

~~The~~Device 110 could be fabricated by means of the following steps of the method set forth in the second preferred embodiment ~~method may fabricate device 110~~:

(a) An ~~N~~ n-type silicon wafer 112 is doped with ~~phosphors~~phosphorus atoms, ~~112,~~ concentration of ~~10 sup 15 centimeters sup~~ 10^{15} cm^{-3}, thickness 0.5 microns.

–(b) A layer of silicon dioxide (~~Sao2~~SiO_2) 116, typically 1 micron thick, is grown over ~~surface of~~ the wafer ~~at temperature of 1100oC to protects~~ surface, ~~acted as~~ at temperature of 1100°C, to protect the surface which serves as a barrier to dopants during the remainder of processing. Photoresist is deposited onto the surface of the wafer and spun to achieve an even distribution of the required thickness.

–(c) ~~Photoresist~~ The photoresist layer is exposed to ultraviolet light through a mask,

which defines the regions into which diffusion is to take place together with the transistor channels. Areas exposed to UV radiation are ~~polymerised~~polymerized.

(d) The exposed areas are etched away together with the underlying silicon dioxide to expose the wafer surface in the window defined by the mask.
~~dioxide to expose the wafer surface in the window defined by the mask.~~
~~(f) Thin~~
(e) A thin layer of SiO_2 ~~(~~112, 0.~~1micron typical) 112~~1 micron thick, is grown over the entire chip surface. Polysilicon is deposited on top of the gate oxide ~~and formed~~ to form the gate structure **122**~~, then~~. A phosphorus atom dopant concentration of ~~10 sups 16 centimetre sup~~ 10^{16} cm^{-3} ~~are~~, is deposited by Chemical ~~Vapour deposition~~Vapor Deposition (CVD) at a temperature of 1230°C.
~~(CVD) on temperature of 1230 oC.~~

~~(g) P+ Source/Drain - Further~~
(f) P+ source/drain: further photoresist coating and masking ~~allows~~ enables patterned polysilicon. ~~Thin~~

(g) The thin oxide layer is removed to expose areas into which ~~P~~p-type impurities are to be diffused ~~and formed~~to form the source **118** and drain **120** ~~-~~.regions. The diffusion is processed by —gas flow ~~contained P~~containing p-type impurity ~~Boron~~ boron dopants ~~into~~ regions **118** and **120**~~—regions~~, concentration of ~~10 sup 17 centimetre sup~~ 10^{17} cm^{-3} over the surface at high temperature.

(h) ~~Thick~~A thick oxide (SiO_2) layer is grown over the entire wafer again~~.~~ ~~Masked~~, masked with photoresist and etched to expose selected areas over the polysilicon gate and the source/drain regions **118**, **120**, where the contact connections are ~~to be~~ made.

(i)~~Thin layer~~ A thin later of SiO_2, 0.1 micron ~~typical~~thick, is grown~~;~~ over the entire chip surface. ~~Aluminium of~~ Aluminum, typically 1 micron thick, is deposited over the entire wafer surface~~. Metal~~. The metal layer is masked and etched to form the required interconnection pattern. A passivating oxide (over-glass oxide) is deposited to protect the wafer pattern; the contact holes are patterned for device pad points. The back of the wafer is ~~metallised~~metallized for substrate connection.

MODIFICATION AND ADVANTAGES

The dimensions and materials of the preferred embodiment switching devices can be greatly varied while still preserving the mode of operation. The silicon system could be replaced with other systems such as ~~gallium-arsenide~~GaAs, GaN, etc. The devices could be fabricated from thin layers of glass~~es~~, insulators, metals, etc. and still provide ~~the~~ operation as in the preferred embodiments. Instead of phosphorus and boron gates, source and drain dopants could be, for example, n-type: arsenic, antimony or p-type: gallium, ~~borin~~boron; the concentration of the dopants could ~~be changed~~ also be changed. Insulation materials and contacts can be greatly varied.

Holes could be the carrier instead of electrons ~~could be the carrier~~, or even both holes and electrons transported in opposite directions simultaneously. Either dimensional changes or material changes or combinations could change the particles energy levels.

Various geometries are available, such as interdigitated base and emitter, source and drain, multiple emitters, multiple collectors, multiple bases, multiple gates, multiple sources, multiple drains, multiple detectors and so forth.

Different ~~value of~~ current, voltage or temperature values could be embedded in the device.

The invention deals with new switching methods that included ~~embedded~~embedding in different structures, devices and fabrication methods and could be integrated ~~to a striacture~~into a structure containing more than one device.

The switching speed and device size could be adjusted ~~so that by~~through the use of various device ~~strictures~~structures, specifications and materials.

Any of the switching methods described in this patent could be combined with any of the detection methods described in this patent; in addition, other detection methods could be embedded in the device.

Other triggered switching methods ~~for example~~, such as ultrasound pulses, could be embedded in the device.

The device can be operated in either the enhancement mode or ~~in~~ the depletion mode by adjusting the structure and materials.

The advantages of the preferred embodiments and modifications include high switching speed, small devices, low energy consumption and low heat emission.